THE VK6 BROADBAND END FED ANTENNA

A M Keightley VK6YX
242 Serpentine Rd, Albany, WA 6330

A low noise, low SWR, 160 to 20 metre antenna only 22½ metres long.

The basis of this antenna design is from two main sources, firstly the development of a three wire end fed antenna for amateur use by John VK6IM of Australind, with whom I have conducted on air tests for many months, (mainly on 160 metres) and secondly the recent article in 'AR' of April 1982 'The Australian Broadband Antenna'.

Prior to the testing with VK6IM I had the belief that, generally, end fed antennas suffer from the problem of powerline and man-made noise pickup much more than a balanced antenna. John kept describing the low noise pickup of his developing antenna, so I gradually became interested in thinking how the good characteristics of his design could be improved to reduce the SWR excursions being experienced. Much thought was given to the many possible methods of assembly to reduce the possibility of corrosion problems of dissimilar metals, to reduce the weight while retaining good strength.

DESCRIPTION

Figure 1 shows the general arrangement of the final design. The antenna consists of two parts joined by a parallel connected resistor and inductor. The lower section is connected to the feed line via a balun. The upper section is about half the length of the lower section. Both sections are in a five-wire cage configuration. Further details are given later in this article.

TESTING

An antenna was constructed, erected and considerable testing conducted to determine its characteristics. It was installed between two towers with the feed end at ten feet and the far end at thirty feet. First testing was done by taking an FRG7 receiver and an RX noise bridge up the tower to the feed point and recording the antenna impedance from 1.7 to 16 MHz. Coils from 12 to 30 micro-Henry were tried before selecting 19μH. As this value gave the most satisfactory results, although it is not critical. These feed impedance figures were very interesting, showing a gradual drop below 2 MHz, a peak at 8 MHz and a gradual rise above 12 MHz, with the noise bridge indicating some 154 ohms over most of this range. *See Fig 2.*

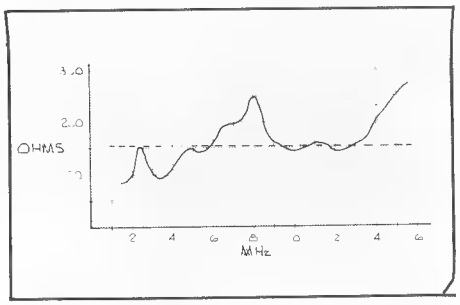

Fig 2 Noise bridge readings taken with Polomar R-X noise bridge and Yaesu FRG7 receiver at the feed point.

An Amidon T200-2 powdered iron core was obtained and a suitable matching transformer constructed to permit transmitting tests to be conducted and recorded. As indicated in the Amidon literature, the use of one of these should tend to reduce the SWR excursions. This proved to be the case and the results showed that the transformer characteristics seemed to compliment the antenna performance, with the resulting SWR not exceeding 1.2:1 from 1.8 to 14.35 MHz. *See Fig 3.*

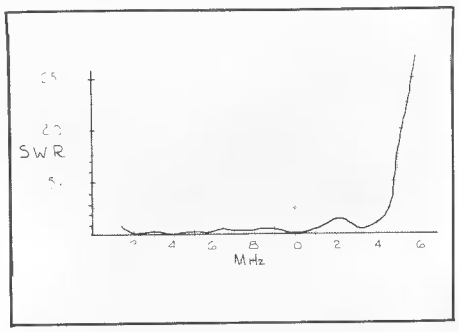

Fig 3 SWR indications recorded at transmitter end of coax using matching transformer at the feed point.

Next some listening tests were conducted, comparing audible signal to noise ratios, between the test antenna and several verticals and a dipole antenna on commercial frequencies. These certainly showed the low power line noise pickup and while signals were a little down compared to some of the antennas, the readability of signals were greatly improved on the broadband antenna. Some simple radiation tests were conducted from twelve locations reasonably equally spaced at some three kilometres radius on roads thoughtfully provided by the powers that be. Two Drake TR7 transceivers were used, mobile and at the base. Ten watts were used for the tests, taking care that the vehicle was oriented in the same direction

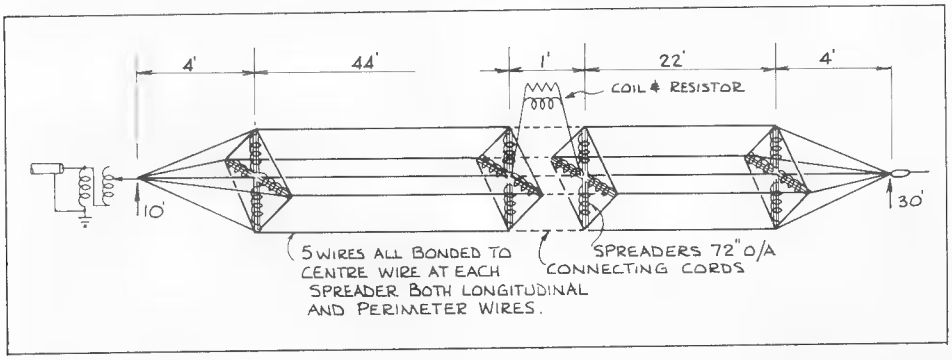

Fig 1 General arrangement of the Broadband Antenna.

compared to the test antenna. Received signal strengths were recorded in both directions on 160, 80, 40 and 20 metres. These showed a nearly circular radiation pattern on each band. Tests were then conducted over a radius of 53 kilometres on the amateur bands and some testing on a commercial frequency. These confirmed that the antenna was working up to expectations, particularly on 160 metres, which was providing excellent communication throughout the day; some 480 kilometres were travelled on this occasion, mostly 50 to 70 kilometres radius from the test antenna. The five-wire design was proving to be as effective as hoped.

CONSTRUCTION

The wire used for the antenna is single strand .85 mm half-hard copper wire. The antenna is strong, because of the five wires in parallel and is suitably light in weight. The spreaders are 6 mm diameter fibre glass rods purchased from a city plastics supply company in three metre lengths. These are cut into 73 inch lengths and drilled in the centre and at 1½ inches in from each end, with a 1/16 inch drill, the end holes being at right angles to the centre hole. The imperial measurements came about by using an imperial rule and materials on hand. Some 1/16 inch stainless steel weld wire is cut into four, one inch pieces and sixteen pieces, ¾ of an inch long. The long pieces are hammered through the centre holes of two rods. The shorter pieces are then driven into the end holes; these are to prevent the antenna wires from moving along the rods. Take one spreader assembly and using a clove hitch, attach the end of some .85 mm copper wire to the end of one rod, above and below the pin leaving about three inches of pigtail. Pull the hitch tight. *See photo 1.* Measure from the centre of the rod, 51.9 inches and mark the wire with a wick pen, then place the mark on the next rod in line with the pin and form another clove hitch, pulling it tight. Continue this around the square, adjusting the length of the last one to have the wire taut. Treat the other three spreaders in the same way.

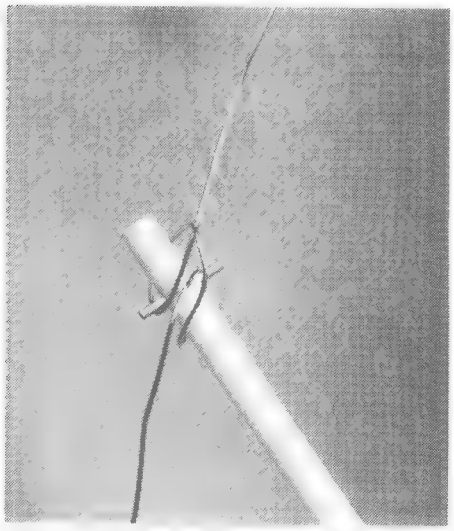

Photo 1 Wire being fitted to spreader rod, showing fibreglass rod and retaining pin.

Procure several metres of 'Vinylon' cord from your friendly butcher who uses it to tie up roasts of beef. This makes excellent supports and halyards for antennas as it does not seem to be effected by sunlight or weather conditions. Cut five pieces about two feet long, attach one end to the end of one spreader assembly using a clove hitch over the wire and pin, then measure along the cord 12 inches, place another mark and attach to another spreader assembly. Do this at each corner and at the centre.

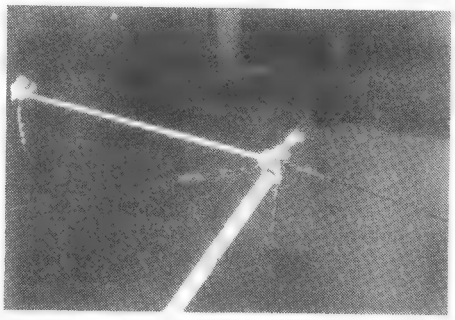

Photo 2 Centre section spreaders showing 12 inch cord tie between two spreaders and the coupling of longitudinal and circumference wires to the central wire.

The next stage requires a flat area some 80 feet long, a concrete driveway is very suitable, and some firm portable supports for each end to attach wires to for the final assembly. Cars, fences, gates can all be pressed into service; the amateur is usually most inventive here.

Several helpers will be useful for this phase of the construction. Have one person hold a spreader vertical, resting it on the ground about five feet from one end support. Tie a piece of .85 mm wire to the spreader using a clove hitch and leaving about six feet of pigtail. Tie this to the support, level with the spreader centre. Measure along the wire 44 feet from the spreader, mark the wire and cut it off about six inches longer. Now attach the wire to one of the centre pair of spreaders at its centre. Attach the end of another piece of wire to the centre of the other spreader pair, leaving a pigtail, measure along 22 feet, mark the wire before cutting it off some six feet longer and attach it to the centre of the remaining spreader. Pulling firmly, attach it to the end support some five feet away and in line with the centre. Continue this method of assembly for the next four wires placed at the ends of the rods remembering to place the wire above and below the pins to prevent it sliding along the rods in use. The next job is to bond each of the longitudinal wires to the spreader squares at each spreader, both sides of each rod. Now attach another wire to a longitudinal wire, spiral it around the rod seven or eight times to the centre and tie it to the centre wire. Do this on each rod of every spreader, effectively bonding all wires to the centre wire.

A suitable egg-type insulator is now fitted to the centre wire four feet from an end spreader and tied off. Carefully attach each of the remaining wires, keeping even tension on each wire while ensuring the insulator remains in line with the antenna centre. Carry out the same insulator installation at the other end. Now fit two feet of multi-strand flexible insulated wire to the antenna at the insulator on the long end and secure through the insulator. Attach two similar wires one foot long to the centre wires at the centre spreaders. Now all the twisted joints are to be soldered and suitably protected from oxidisation by an application of Silastic or similar material. Incidentally, do not use 'RTV732' as the chemical action during curing is corrosive to copper. 'RTV738' does not have this problem and can be used with confidence on any copper materials.

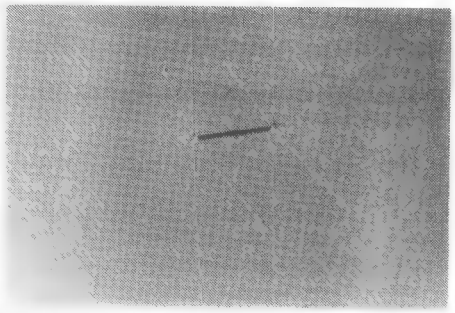

Photo 3 View of the centre section with inductance and resistors fitted.

LOADING COIL

The loading coil is 50 turns of 1 mm enamelled wire close wound in the centre of one inch OD PVC tubing, 14 inches long. Drill two small holes through the conduit to secure the ends of the coil. Cut and tin these ends and solder six 2.2 kohm one watt resistors in parallel across the coil as shown in photo 4, the coil assembly should now be mounted in the centre of the centre spreader assembly and secured with some of the Vinylon cord, the flexible wires from the antenna centre wires shortened and soldered to the coil ends. Now protect the coil-resistor assembly from the weather by a coating of Silastic or similar.

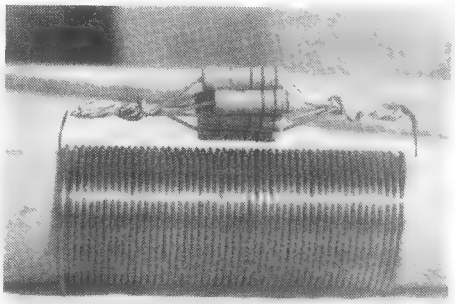

Photo 4 Inductance and resistors.

MATCHING TRANSFORMER

Obtain about 4½ feet of two different coloured 1 mm enamelled winding wire. Twist the wires together at one end and hold in a vice. Pull the wires tight, cut them off to the same length, twist the free ends together for about a half inch and place into the chuck of a hand drill. Keeping the wires stretched firmly, wind the drill to twist the wires until there are one and a half twists per centimetre. Now wind 24 turns of

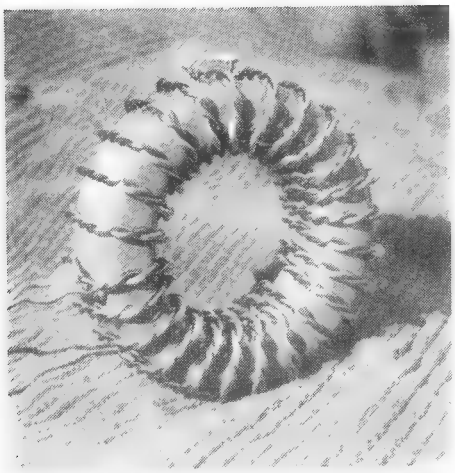

Photo 5 Matching transformer showing tapping method.

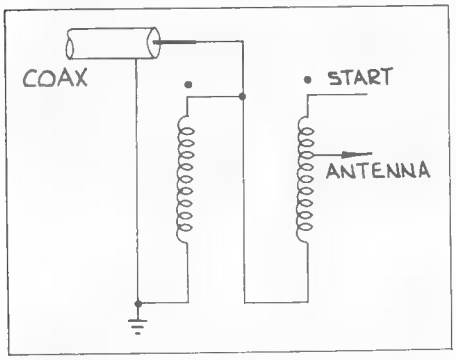

Fig 4 Matching transformer wiring.

the twisted pair on to an Amidon T 200-2 powdered iron core. Keep the turns right onto the surface of the core by forming a slight reverse bend to the wire as it is placed on the flat portions. Connect the start of one winding to the end of the other as indicated in photo 5 and Figs 3 and 4. Count around the core 18 turns, carefully cut the secondary wire, spread the ends away from the other wire and scrape the ends. Loop some 1 mm tinned copper wire around the ends, keeping it away from the second wire and form up a link. Squeeze it firmly onto the wire ends and solder in place. The transformer can now be mounted in a protective box. A square electrical junction box is very suitable as shown in photo 6. A coax fitting and two brass bolts are fitted and the core secured to the bottom of the box with Silastic. A suitable bracket can be fitted to the rear of the box to hold it onto the tower or whatever support is used for the feed end of the antenna, making sure that it is close to the end of the antenna.

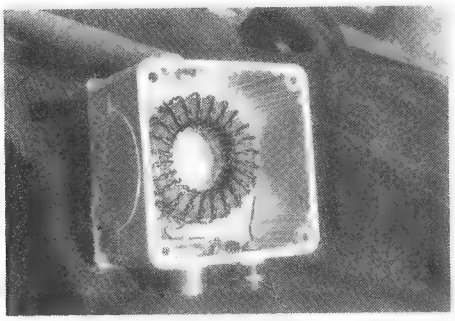

Photo 6 Method used to mount matching transformer in Clipsal 265/3 box.

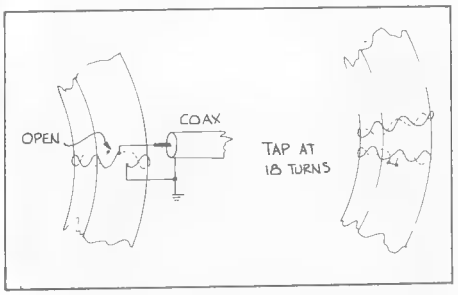

Fig 5 Matching transformer connection detail.

INSTALLATION

Attach the feed end to a suitable support (tower, building, 2 inch water pipe in the ground etc) together with the matching transformer and run a heavy copper wire down to an earth spike, water pipes etc. The earth losses are minimal due to the moderately high feed impedance. The far end can now be hauled up to a suitable support with the antenna end being 30 feet up. Couple to the matching transformer with 50 ohm coax well weather proofed.

USE

It is desirable to use a good low-pass filter (ARRL and RSGB handbooks) at the transmitter to prevent any possible low level spurious signals being radiated, which would normally be attenuated by the usual fairly high 'Q' antenna systems we use. This enables the antenna tuning unit to be taken out of circuit for this antenna, making band changing for those with solid state rigs, a breeze. The results with a general coverage receiver are very pleasing, compared to what we usually experience with the usual 80 metre dipole. By all means check the SWR and be amazed at the very low readings obtained, enabling the solid state rigs to give full output on all bands from 160 to 20 metres, not forgetting 30 metres.

CONCLUSION

I believe this antenna meets the need many amateurs have for a good 160 metre antenna which can be fitted into the average suburban back yard, as it requires only 75 feet of length. The added bonus of low noise pickup and performance continuously to the top of 20 metres makes it very worthy of consideration. Those amateurs using transceivers with general coverage receiving capability, will also appreciate this antenna.

AR

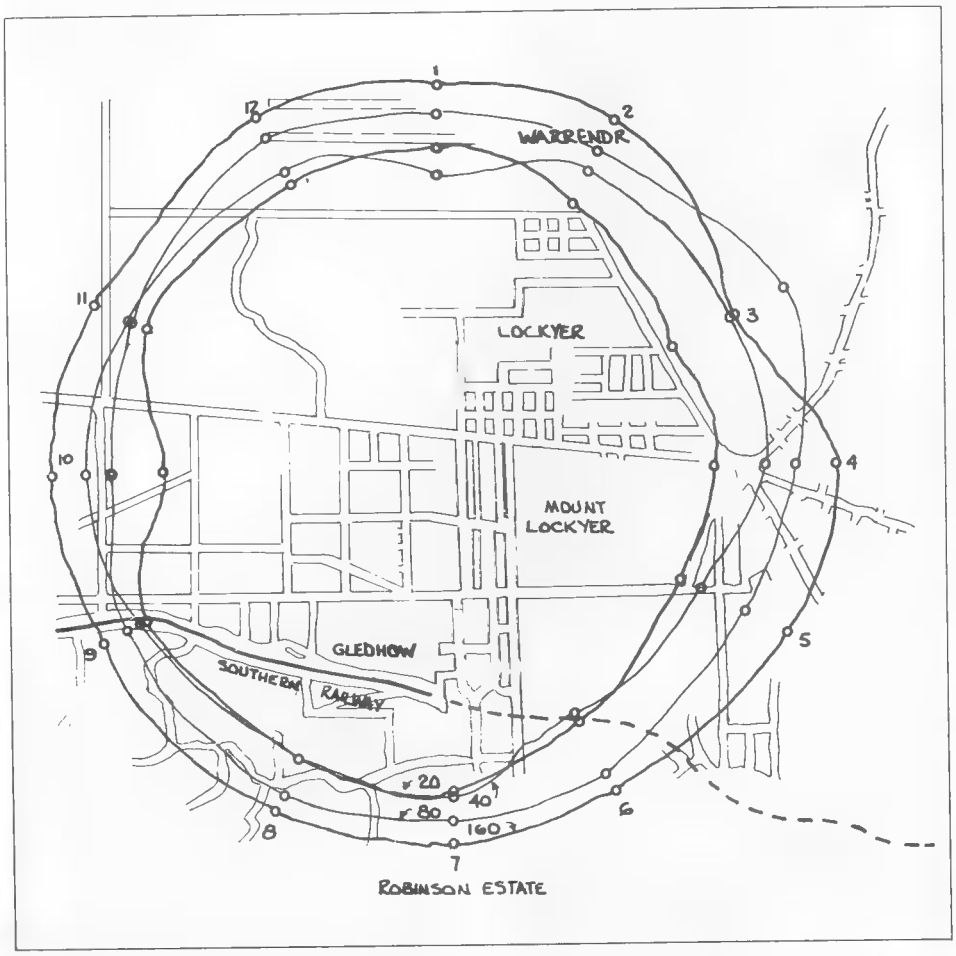

Fig 6 Amateur band radiation test results.